Macromolecular Femtosecond Crystallography using High Density Crystal Holders

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Efficient sample delivery methods are essential to carryout productive femtosecond crystallography experiments at X-ray free electron lasers such as the Linac Coherent Light Source (LCLS). During these experiments often only a single still image may be collected from each crystal and data from hundreds of crystals must be combined to produce a useful dataset. For the collection of radiation sensitive crystals in limited supply, a new experimental station, the Macromolecular Femtosecond Crystallography (MFX) instrument is under development at the LCLS with first experiments planned for July 2016. The MFX experimental front-end is based on developments at SSRL and LCLS XPP to provide an efficient framework for experiments using automated strategies tailored to handle a variety of sample requirements, crystal sizes and experimental goals. New methods to efficiently deliver crystals on fixed targets will be supported at MFX. A high density sample grid, useful for both crystal growth and data collection, contains 75 mounting ports and fits inside a SSRL cassette or uni-puck for automated sample mounting onto the beamline goniometer. The use of grids expands cassette capacity up to 7,200 sample ports. Automated routines have been added to the Blu-Ice/DCSS experimental control system to support grids including semi-automated grid alignment, fully automated positioning of grid ports, rastering, and automated data collection. Methods to map multiple crystals in random orientations within grid ports and other high density sample holders for automated positioning for diffraction data collection will also be described. Grids may serve as a scaffold for crystal growth. With the use of a universal adaptor, crystallization experiments have been setup on grids using commercial liquid handling robots. Specialized crystal growth containers support hanging or sitting drop experiments and LCP crystallization on grids. The MFX project and recent results using radiation sensitive crystals in limited supply at LCLS-XPP will be described.